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Henioehus diphreutes Jordan, a valid speeies of butterflyfish (Chaetodontidae) from the Indo-West Paeifie

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Abstract

The wide-ranging Indo-Paeifie butterflyfish *H. aeuminatus*, as presently reeognised eemprises two speeies. The true *acuminatus* oeeurs from the eoast of East Afriea aeross the Indo-West Paeifie to the islands of Oeeania and is eharaeterised by 11 dorsal spines. *H. diphreutes* is distinguished by the presenee of 12 dorsal spines and also differs from *H. aeuminatus* in morphology, eoloration, eeology, and behaviour. It has an apparent reliet distribution whieh ineludes the Hawaiian Islands, Japan, New South Wales, Western Australia, Maldive Islands, South Afriea, and the Red Sea.

Introduction

The butterflyfish genus *Heniochus* eontains seven speeies whieh are primarily eonfined to the reefs of the tropieal Indo-West Paeifie region. Perhaps the best known speeies is the Bannerfish, *H. acuminatus*, deseribed by Linnaeus (1758) from Indian Seas and subsequently reported by various authors from widespread loealities in the Indian and Paeifie Oeeans. Most reeent authors, ineluding Klausewitz (1969) who revised the genus, are in agreement with regards to the use of the name *acuminatus* for this speeies. *H. macrolepidotus*, also deseribed by Linnaeus was frequently reeognised as a distinet elosely related speeies during the 19th eentury, but is now generally regarded as a junior synonym of *acuminatus*. Another speeies whieh has been plaeed in the synonymy of *acuminatus* by Fowler and Bean (1929) and Weber and de Beaufort (1936) is *H. diphreutes* Jordan (1903) deseribed from Japan. However, Klausewitz failed to mention it either as a synonym or valid entity.

The senior author made several field trips to Eniwetok Atoll, Marshall Islands while residing in Hawaii between 1967 and 1971. During this period individuals of *Heniochus acuminatus* were frequently observed while SCUBA diving at both Hawaii and Eniwetok. Speeimens from the two loealities appeared to be morphologieally similar, although a detailed eomparison was not made at the time. However, there was a very noticeable differenee between the two populations with regards to eeology and behaviour. The Hawaiian fish eharaeteristieally oeeurs over roeky areas in aggregations whieh may inelude more than 100 individuals. Furthermore, they swim well above the bottom and apparently forage on plankton. Members of the Eniwetok population, on the eontrary, were nearly always sighted alone or in palrs and oeeurred near the bottom in the vieinity of coral reefs.

Klausewitz (1969) eommented that *H. aeuminatus* is often falsely assumed to be a reef inhabitant, but pointed out that it prefers shallow eoastal waters, in bays, lagoons, estuaries, and along roeky eoasts. His observations were largely, if not entirely, based on the population eeeurring at Eilat, northern Red Sea. He further noted that most speeimens of *H. "acuminatus"* from the Indo-Paeifie had 11 dorsal spines while those from the Gulf of Aqaba, Red Sea had 12. He also reeorded a differenee in the number of soft dorsal rays and maximum length between individuals from these two areas. He eoneluded that the Red Sea population might be deserving of sub-speeifie status. The present study, however, indieates that these populations are distinet.

Between 1971 and 1973 the senior author eolleeted fishes and made underwater observations at the Caroline Islands, Great Barrier Reef of Australia, New Guinea, New Britain, Solomon Islands, New Hebrides, New Caledonia, and the Fiji Islands. *H. acuminatus* was obserVed at all these loealities and the behaviour and eeology in eaeh plaee was similar to that of the Eniwetok population. During 1973 the junior author eolleeted two very similar speeies of *Heniochus* from Sydney, Australia whleh when

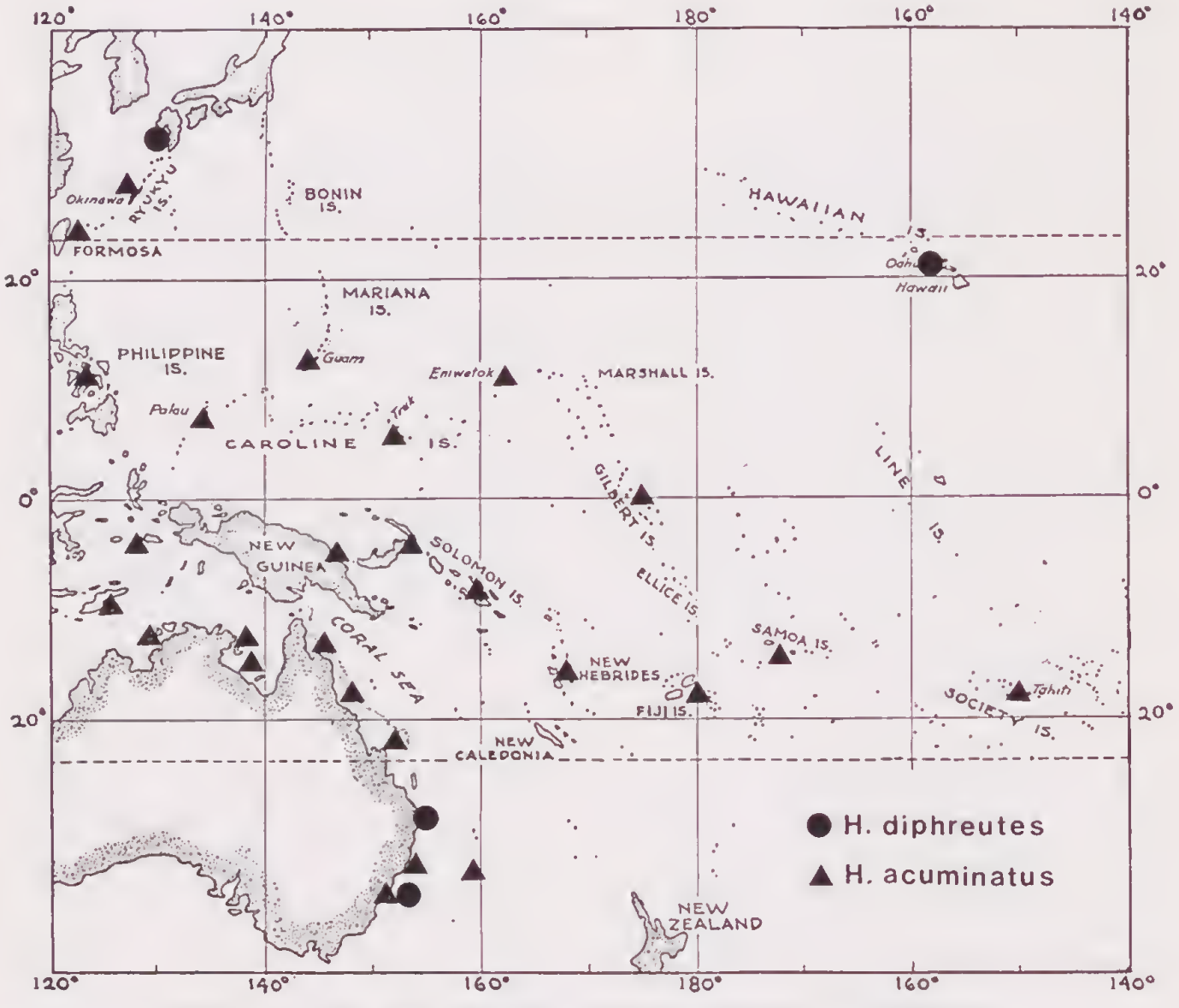

Figure 1. — Pacific Ocean distribution of *Heniochus acuminatus* and *H. diphreutes*.

first presented to the senior author for identification were believed to be only morphological variants of *H. acuminatus*. An adequate sample of both forms was eventually procured and a detailed comparison of this material supplemented by additional underwater observations reveals that they are indeed distinct. A subsequent literature search indicates that one of these is the widespread *H. acuminatus* and the other is *H. diphreutes* which perhaps has a relict distribution including Hawaii, Japan, New South Wales, Western Australia, Maldive Islands, South Africa, and the Red Sea. The two species are compared and a brief diagnosis for each is presented below. Selected fin ray counts are presented in Table 1 and the distributions are summarised in Figs. 1 and 2. The latter were compiled from Fowler and Bean (1929), Weber and de Beaufort (1936), Klausewitz (1969), personal observations, and examination of museum specimens.

The following abbreviations are used in the subsequent text: AMS—Australian Museum, Sydney; BPBM—Bernice P. Bishop Museum, Honolulu; CAS—California Academy of Sciences, San Francisco; JLBS—J.L.B. Smith Institute of Ichthyology, Grahamstown, South Africa; QM—Queensland Museum, Brisbane; SMF—Natur-Museum Senckenberg, Frankfurt; SU—Stanford University, California (specimens now deposited at CAS); WAM—Western Australian Museum, Perth.

Heniochus acuminatus (Linnaeus)

(Figs. 3 and 4; Table 1)

Chaetodon acuminatus Linnaeus, 1758: 272 (type locality, Indies).

Chaetodon macrolepidotus Linnaeus, 1758: 274 (type locality, Indies).

Chaetodon bifasciatus Shaw, 1803: 342 (type locality, Indian Seas).

Chaetodon myceteryzans Gray, 1854: 76 (no locality given).

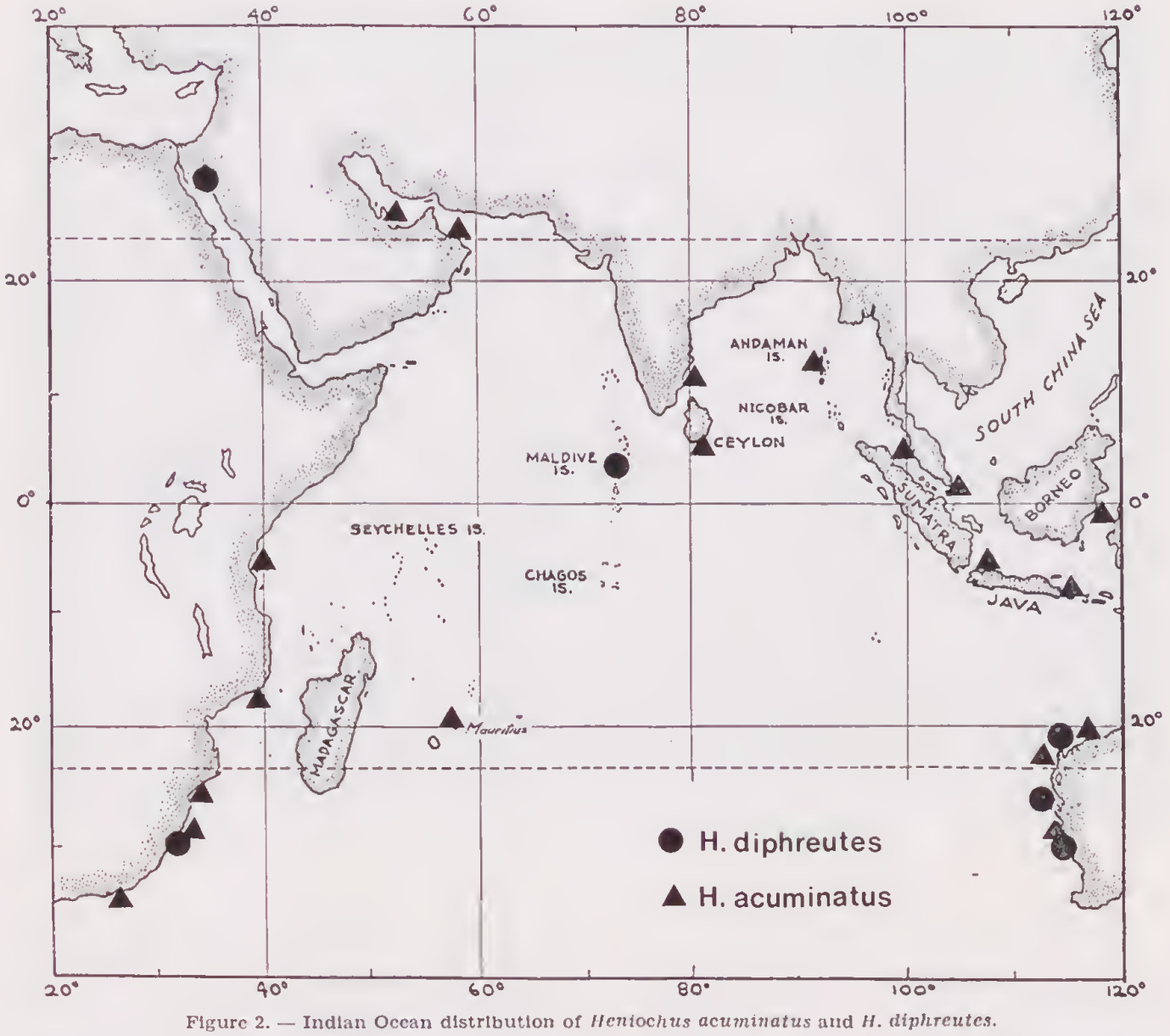

Figure 2. — Indian Ocean distribution of *Heniochus acuminatus* and *H. diphreutes*.

Material examined: 111 specimens, 22.8-196.0 mm SL.

Australia-New South Wales: AMS IA.177, 113.3 mm SL (no locality); AMS IB.2929, 26.5 mm SL (Newcastle); AMS IB.5707, 2 specimens, 24.0-44.8 mm SL (Lord Howe Island); AMS IB.5742, 75.4 mm SL (Sydney Harbour); AMS IB.5744-5745, 2 specimens, 33.2-53.5 mm SL (Sydney Harbour); AMS IB.8104, 47.1 mm SL (Port Hacking); AMS IB.8208, 66.7 mm SL (Woolongong); AMS I.15575-001, 52.5 mm SL (Woolongong); AMS I.15778-003, 44.0 mm SL (Port Macquarie); AMS unregistered, 112.0 mm SL (Lord Howe Island); WAM P25632-001, 2 specimens, 22.8-35.7 mm SL (Lakes Entrance); WAM P25633-001, 4 specimens, 25.9-41.5 mm SL (Sydney); WAM P25634-001, 2 specimens, 40.3-43.4 mm SL (Sydney); WAM P25635-001, 58.0 mm SL (Sydney); WAM P25636-001, 2 specimens, 35.0-36.0 mm SL (Sydney Harbour); WAM P25637-001, 2 specimens, 29.2-54.5 mm SL (Sydney Harbour); WAM P25638-001, 123.6 mm SL (Sydney). Queensland: AMS IA.1750-1752, 3 specimens, 54.7-57.3 mm SL (Port Denison); AMS I.15557-197, 65.0 mm SL (Gulf of Carpentaria); QM I.1777-1778, 2 specimens, 79.0-92.0 mm SL (Moreton Bay); QM I.3467, 166.0 mm SL (Moreton Bay); WAM P24688, 34.3 mm SL (Lizard Island); WAM P24701, 38.5 mm SL (Lizard Island); WAM P24714, 3 specimens, 30.0-33.0 mm SL (Lizard Island). Western Australia: WAM P4432, 52.0 mm SL (Exmouth Gulf); WAM P4438, 5 specimens, 77.0-152.0 mm SL (Dampier Archipelago); WAM P4453, 81.5 mm SL (Exmouth Gulf); WAM P4763, 196.0 mm SL (Wedge Island); WAM P5329, 71.5 mm SL (Exmouth Gulf); WAM P6101, 55.6 mm SL (Exmouth Gulf); WAM P8347, 56.2 mm SL (Point Quobba); WAM P24068, 149.5 mm SL (Dampier Archipelago); WAM P25113-006, 124.6 mm SL (Dampier Archipelago); WAM unregistered, 2 specimens, 53.0-57.2 mm SL (North West Cape).

East Africa: SMF 8241, 47.0 mm SL; SMF 11557, 5 specimens, 75.0-91.0 mm SL (Dar es Salam).

Fiji Islands: AMS I.7465, 82.9 mm SL (Suva).

India: AMS I.54, 120.6 mm SL (Madras); SMF 6773, 4 specimens, 75.0-141.0 mm SL (Madras).

Indonesia: SMF 3965, 62.0 mm SL (Jakarta); SMF 8242, 2 specimens, 91.0-114.0 mm SL (Celebes).

Madagascar: SMF 10379, 6 specimens, 94.0-148.0 mm SL.

Mauritius: SMF 1705, 2 specimens, 81.0-140.0 mm SL.

Figure 3. — *Heniochus acuminatus*, 151 mm SL, Bahrain, Persian Gulf (J. Randall photo).

Persian Gulf: BPBM unregistered, 6 specimens, 60.0-151.0 mm SL (Bahrain); SMF 9803, 5 specimens, 83.0-108.0 mm SL; SMF 11974, 3 specimens, 91.0-93.0 mm SL (Kuwait).

Philippine Islands: AMS I.10575, 79.0 mm SL (Cebu); SMF 9262, 4 specimens, 64.0-78.0 mm SL.

Sri Lanka: SMF 4267, 6 specimens, 54.0-61.0 mm SL; SMF 8243, 3 specimens, 64.0-73.0 mm SL; SMF 9117, 3 specimens, 85.0-115.0 mm SL; SMF 9120, 89.0 mm SL; SMF 10748, 2 specimens, 62.0-84.0 mm SL; SMF 12208, 74.0 mm SL.

Diagnosis: Dorsal rays usually XI (rarely XII), 24 to 27; anal rays III, 17 to 19; pectoral rays 15 to 18; tubed lateral-line scales 47 to 54.

The following proportions are based on 10 specimens, 53.0-196.0 mm SL; depth of body 1.2 to 1.4, head length 2.6 to 3.1, both in standard length; snout length 2.7 to 3.3, eye diameter 2.5 to 3.6, interorbital width 2.9 to 3.8, caudal peduncle depth 2.7 to 3.7, pectoral fin length 1.0 to 1.2, pelvic fin length 0.9 to 1.1, anal fin length 1.0 to 1.3 all in head length.

Colour in alcohol: ground colour of head and body yellowish-white or tan; dorsal portion of snout blackish; lower lip and chin frequently with black smudges; a blackish bar connecting orbits across interorbital region; body with two oblique black bars, the first encompassing anterlormost dorsal spines and posterior part of nape extending to abdomen, becoming gradually broader ventrally, the lowermost width extending approximately from pelvic base to anus; the second bar extending from distal part of 6th-8th dorsal spines to ventral half of anal fin, more oblique in position than first bar and of more uniform width; dorsal fin greyish-white to yellowish except where interrupted by dark bars; caudal fin yellowish; anal fin yellowish-tan on anterior half, black posteriorly (continuation of second body bar), anal spines and anterior edge of soft anal also black; pelvic fins black; pectoral fin yellowish with black base and axil.

Colour in life: similar to preserved coloration except filamentous extension of fourth dorsal spine and ground colour of body generally whitish, and region posterior to second body bar largely yellow grading to translucent on distal edge of soft dorsal and caudal fins.

Remarks: This species generally occurs solitarily or in pairs, usually in coral reef areas. However, at certain subtropical or warm temperate localities it may be encountered over rocky substratum. The young are frequently seen around caves and crevices. We have observed the species at depths ranging from about 2 to 30 m, but it is most often encountered between 5 and 15 m.

Figure 4. — Juvenile specimens of closely related *Heniochus* collected at Sydney, Australia: left — *H. acuminatus*, 58 mm SL; right — *H. diphreutes*, 51.8 mm SL.

Nomenclature: Linnaeus (1758), in his brief description of this species, gave a dorsal ray count of "3/28" (i.e., three spines and 25 soft rays or 28 total elements). This must certainly represent an error as the description is apparently based on the specimen illustrated by him in 1754 (Linnaeus 1754, plate 33, fig. 3). The illustration clearly shows at least 11 dorsal spines and the characteristic snout shape of *acuminatus* (see discussion of comparative morphology under *H. diphreutes*). Furthermore, B. Broberg of the Naturhistoriska Riksmuseet in Stockholm (the depository of many Linnaean types) has confirmed the existence of the type specimen in their collection. He stated that the specimen "is in good condition and agrees very well with the figure in Museum Adolphi Friderici (Linnaeus 1754) and still retains much of the original pattern of coloration. Dorsal spines of the specimen are 11 and the pectoral rays are 16 on one and 17 on the other side. Standard length is 67.3 mm and the three anal spines appear dark".

Comparisons: H. acuminatus differs from *H. diphreutes* by having 11 (rarely 12) dorsal spines instead of 12 (rarely 13), a longer snout, a longer anal fin, and a shorter pelvic fin. There are also differences in coloration, behaviour, ecology, and postlarval size. These are summarised in the comparisons section for *H. diphreutes*. Less than 1% of the specimens examined possessed an abnormal count of 12 spines, and these were from widely scattered localities. Identification was facilitated in these cases primarily on the basis of snout shape and the length of the pelvic and anal fins.

Distribution: (see maps, Figs. 1 and 2) *H. acuminatus* appears to be widespread in the tropical Indo-West Pacific from the coast of East Africa to the islands of southeastern Polynesia. However, some of the published records (such as those from Hawaii and the Red Sea) are no doubt attributable to *H. diphreutes*. The senior author has observed it at the Society Islands, Marshall Islands, Fiji Islands, New Hebrides, Solomon Islands, New Britain, New Guinea, Palau Islands Ryukyu Islands, Philippine Islands, Indonesia, eastern Australia (Great Barrier Reef and Sydney), Lord Howe Island, Western Australia, Sri Lanka, Persian Gulf, and Gulf of Oman. It appears to be largely allopatric with *H. diphreutes*, but the two species occur together at certain localities such as Exmouth Gulf, Western Australia;

Figure 5. — *Heniochus diphreutes*, 100 mm SL, Oahu, Hawaiian Islands (J. Randall photo).

Sydney, New South Wales; and the Durban area of South Africa (based on specimens examined for us by M. M. Smith).

Heniochus diphreutes Jordan

(Figs. 4 and 5; Table 1)

Heniochus diphreutes Jordan, 1903: 694 (type locality, Wakamoura, Japan).

Material examined: 23 specimens, 36.0-134.0 mm SL.

Australia—New South Wales: AMS IB.5743, 46.0 mm SL (no locality); WAM P25640-001, 3 specimens, 48.8-52.0 mm SL (Sydney); WAM P25641-001, 2 specimens, 67.8-74.3 mm SL (Port Stephens); WAM P25642-001, 6 specimens, 38.8-47.5 mm SL (Sydney); WAM P25643-001, 2 specimens, 47.5-55.0 mm SL (Sydney Harbour); Western Australia: WAM P5912, 36.0 mm SL (30°37'S, 115° 04'E); WAM P15448, 40.0 mm SL (Shark Bay); WAM P25095-039, 2 specimens, 62.3-67.5 mm SL (Exmouth Gulf); WAM unregistered, 65.0 mm SL (Exmouth Gulf).

Hawaiian Islands: AMS IA.186, 110.5 mm SL (Honolulu).

Japan: SU 7247, 41.3 mm SL, holotype (Nagasaki).

Maldive Islands: SMF 8712, 134.0 mm SL (Ari Atoll).

Diagnosis: Dorsal rays usually XII (rarely XIII), 23 to 25; anal rays III, 17 to 19; pectoral rays 16 to 18; tubed lateral-line scales 46 to 54.

The following proportions are based on eight specimens, 52.0-110.5 mm SL: depth of body 1.2 to 1.5, head length 2.4 to 3.0, both in standard length; snout length 3.0 to 3.7, eye diameter 2.6 to 3.1, interorbital width 3.3 to 3.6, caudal peduncle depth 2.7 to 3.4, pectoral fin length 1.0 to 1.2, pelvic fin length 0.7 to 0.9, anal fin length 1.3 to 1.5, all in head length.

Colour in alcohol and life: the coloration is nearly identical to *H. acuminatus* except the anal spines, at least in juvenile specimens under about 60 mm SL, are usually whitish or only slightly dusky. In addition, young specimens

when alive usually have a white area on the back between the second black bar and the soft dorsal fin.

Nomenclature: H. diphreutes Jordan is the oldest name for the 12-spined *"acuminatus"*. We have examined the type, a specimen (SU 7247) 41.3 mm SL, collected at Nagasaki, Japan by D. S. Jordan and J. O. Snyder during the summer of 1900. We recorded the following counts and measurements (expressed in percent of the standard length) from this specimen: dorsal rays XII, 24; anal rays III, 18; pectoral rays 18; tubed lateral-line scales 48; depth of body 62.0 (1.6 in SL); width of body 12.6; head length 36.8 (2.7 in SL); snout length 10.2 (3.6 in head); eye diameter 13.6 (2.7 in head); interorbital width 10.4 (3.6 in head); caudal peduncle length 4.8; snout to dorsal origin 49.9; snout to anal origin 74.1; snout to pelvic origin 44.3; pelvic fin length 49.4 (0.7 in head); pelvic spine length 28.6; pectoral fin length 32.4 (1.1 in head); dorsal fin base 73.8; anal fin base 25.2; length of first dorsal spine 13.3, of fourth dorsal spine (including filamentous portion) 107.5, of last dorsal spine 13.8, of longest soft dorsal ray 22.8 (1.5 in head), of first anal spine 11.1, of second anal spine 21.1, of third anal spine 19.4, of longest soft anal ray 24.7, and of caudal fin 27.4.

Ecology: This species usually occurs in aggregations which may include up to more than 100 individuals. They swim high above the substratum in search of planktonic food, usually above rocky outcrops or some other form of shelter which are frequently located in sandy areas. The depth range extends from about 3 to at least 183 m (Strasburg, *et al.*, 1968).

Distribution: (see maps, Figs. 1 and 2) *H. diphreutes* is here reported from the Hawaiian Islands, southern Japan, New South Wales, Western Australia, Maldive Islands, South Africa (Durban area), and the Red Sea. If the above mentioned areas represent the total distribution it would appear that *H. diphreutes* is a relict species, perhaps being once widespread throughout the Indo-West Pacific. It is interesting to note that the existing distribution records are mainly peripheral to the distribution of *H. acuminatus*, for the most part lying barely within the tropics or in warm temperate seas. Perhaps the widespread ancestral population of *diphreutes* became largely extinct because of its lack of ability to successfully compete for food and shelter on the coral reefs of the tropical Indo-West Pacific. It now survives in sandy habitats relatively low in species diversity, largely outside of the tropics. Indeed, it is the only member of the genus not generally associated with coral reefs.

Comparisons: H. diphreutes is readily separable from *H. acuminatus* on the basis of dorsal spine count (12 as opposed to 11 for *acuminatus*), and the modal number of soft dorsal and pectoral rays (see Table 1). In addition, the snout of *diphreutes* is generally less protruding (see Figs. 3-5) and this species has a longer pelvic fin and shorter anal fin than *acuminatus*. We have

Table 1

Comparison of certain counts for Heniochus acuminatus *and* H. diphreutes

Count	Frequency	
	H. acuminatus	*H. diphreutes*
Dorsal spines:		
11	98	
12	6	22
13		1
Soft dorsal rays:		
23		5
24	4	10
25	47	8
26	44	
27	3	
Soft anal rays:		
17	16	3
18	80	18
19	8	2
Pectoral rays:		
15	1	
16	3	2
17	63	19
18	37	2
Tubed lateral-line scales:		
46		2
47	1	1
48	4	3
49	7	2
50	17	3
51	23	4
52	11	5
53	17	2
54	6	1

compared 20 specimens, 36.0-74.3 mm SL ($\bar{x}$ = 50.8 mm SL) of *H. diphreutes* with 41 specimens, 22.8-92.0 mm SL ($\bar{x}$ = 50.7 mm SL) of *H. acuminatus*. The average pelvic fin length of *diphreutes* was 46.8% of the standard length compared with 37.2% for *acuminatus*. The average anal fin height (i.e. length of tallest soft anal ray) of *diphreutes* was 21.5% of the standard length and 32.2% for *acuminatus*. Unfortunately we were unable to obtain a sufficient number of large (in excess of 100 mm SL) *H. diphreutes* for comparisons. However, on the basis of two specimens of *diphreutes*, 110.5 and 134.0 mm SL, and many large specimens of *acuminatus*, it appears that fin length differences are not diagnostic among the adults. The snout shape and number of dorsal spines remain the best means for separating larger individuals.

The general colour patterns of the two species are very similar, but several differences were detected in fresh specimens (primarily juveniles) from the Sydney area. The anal spines of *diphreutes* were white or only slightly dusky and those of *acuminatus* were black. Furthermore there was a difference in the pepper-like dark pigmentation which is located in the yellow area of the upper back and adjacent basal portion of the dorsal fin (primarily the soft portion). In *diphreutes* the pigment is loosely scattered and the outer boundary of the pigmented area on the soft dorsal fin is more or less concave; the pigmentation of *acuminatus* is much heavier and the outer boundary is distinctly convex. In the small (less than about 50 mm SL) juveniles there is a difference in the coloration of that part of the back immediately adjacent to the posterior edge of the second dark body bar. In *diphreutes* there is a narrow white strip separating the second bar from the yellow dorsal fin, whereas the area is solid yellow in *acuminatus*.

The two species also differ in ecology and general diurnal behaviour. *H. diphreutes* is most often encountered swimming in mid-water aggregations in sandy areas with scattered shelter, while *H. acuminatus* is chiefly solitary or forms pairs and is found primarily in coral reef areas near the substratum. However, the juveniles of the latter species are sometimes found in small aggregations.

Finally, there is an apparent difference in the size of postlarval juveniles and adults. The smallest postlarvae of *H. diphreutes* which we have collected are in the 25-30 mm standard length range, whereas those of *H. acuminatus* are about 15 mm SL. Klausewitz (1969) noted that specimens of *acuminatus* reported from various parts of the Indo-West Pacific had a maximum total length ranging from 160-200 mm compared with a maximum of 122 mm in specimens (of *diphreutes*) from the Gulf of Aqaba, Red Sea. We detected a similar difference among the specimens examined during the present study. Our largest specimens measured 238 mm and 134 mm total length for *H. acuminatus* and *H. diphreutes* respectively.

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